Cognitive training in MCI and SCI: Impact on cognition, strategy use and virtual reality measures of real-life cognition

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Cognitive training in MCI

Cognitive training might modify the brain to create a form of late-life reserve.

It might reduce the burden of cognitive impairment in daily life by providing strategy to better perform cognitively demanding activities.

MCI = an ideal target for cognitive training

They are concerned and impaired, able to learn and apply new strategies, the potential benefit is tremendous.
Cognitive training in MCI

What is its efficacy to improve cognition?
Based on trials with **solid designs**
- randomisation, active control condition, large groups, prior identification of the primary outcome.

What is its durability?

Do these transfer in real-life (every day impact)?
Different types of training
(Willis et Belleville, 2016)

- **Therapist-based strategy training**: teaching of new/more efficient ways to complete tasks (e.g.: ACTIVE, MÉMO)

- **Computerized training**: Serious videogames experimental (e.g.: Neuropeak; priority training) or **commercial plateforms** (e.g: Brain HQ, Happy Neuron), **casual videogames** (e.g. Super Mario 64; Crazy taxi)

- **Community-based activities**: Volunteering or intergenerational activities (e.g.: Experience corps), **new cognitively stimulating leisures** – music, second language, digital photography (e.g.: Synapse; Engage)
The MEMO program

Focuses on **memory**: main complaint, main deficit.

Provides a **range** of **strategies** known to increase elaborate encoding + relying on preserved capacities (semantic, visual imagery).

Includes **dual-tasking training**, a deficit present in MCI which might reduce their ability to memorize in real-life distracting conditions.

**Therapist-based small group** format (4-5 people/group)
  allows individual guidance, social contact, healthy emulation

Designed to promote **self-efficacy**: positive information on aging, modeling, gradual difficulty level

**Exercises to favour use of strategy in everyday life**; homeworks, real-life examples, instructions on when to use and not use the strategies.

*Gilbert, Fontaine & Belleville (2007) MEMO: A memory training program for older adults*
Memory strategies

Method of loci

Face name association

M. Field
MEMO+:

- A 6-month single-blind randomized controlled trial with 145 persons with MCI
- 16 hours of training (8 weekly sessions)
- Cognitive training; Active control (psychosocial); Wait-list
- Post; post 3 month and post 6 month
**MEMO**: a strategy-based memory training program

**Structured teaching and training on memory strategies**
- Interactive imagery (1 session)
- Method of Loci (1 session)
- Face-name association (1 session)
- Text hierarchization (1 session)
- Semantic organization (1 session)

**Pre-training**
- Mental imagery and attention control (3 sessions)

**Self-efficacy and transfer to real life**
- Psycho-education
- Gradual increase of difficulty level
- Modeling and group exercises
- Homework + when to use vs not use the strategy

**Imagery based**

**Semantic elaboration**

**Active control:** Psychosocial intervention

**Based on the cognitivo-behavioral approach.**

**Designed to improve general well-being, prevent psychological distress and increase social networking.**
- Psychoeducation
- Solution focused training
- Cognitive restructuring
- Diaphragmatic breathing
- Behavioral activation
- Anger management
- Problem-solving skill training

8 weekly sessions; booster session after 3-month up

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Ouellette, Grenier & Ducharme (2010)
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**Active control: Psychosocial intervention**

**Ouellette, Grenier & Ducharme (2010)**
Measure of efficacy
Composites for immediate and delayed memory

Effect on psychological outcomes
Depressive (GDS) and Anxiety symptoms (GAS); well-being

Questionnaires for transfer in everyday life
Use of strategy in real life (MMQ)
Self-reported memory in daily life (QAM)
Complex activities of daily living (ADL-PI)
Modified ITT analyses; Mixed linear model adjusted for sex, educations and age; Group x Time interaction; \( P<0.01 \), for delayed memory composite

Mean Age: 72.3 yrs; Mean Education: 14.6 yrs; 53.4% women
Increased brain activation in regions related to the learned strategies

Training-related brain plasticity in subjects at risk of developing Alzheimer’s disease

Sylvie Belleville, Francis Clément, Samira Mellah, Brigitte Gilbert, Francine Fontaine, and Serge Gaudier
Strategy based cognitive training improves cognition in persons with MCI and the effect is durable.
Effect on all outcome measures

26 studies (887 MCI received intervention)
Significant moderate effects

Effect on memory measures

Meta-regression: memory-focused interventions were the most effective
Effect on transfer? They more often use strategies … but do not show improvement on self-reported complex activities.

Modified ITT analysis with mixed linear model adjusted for sex, age and education; Group x Time interaction; P<0.01 for strategy use (MMQ)
Meta-analysis of therapist-based interventions:

Moderate transfer on metacognitive abilities (perception of cognitive function) but no impact on mood or self-reported activities of daily living (Chandler, Parks, Mariske, Rotblatt & Smith, 2016).

Lack of transfer was raised as a major drawback for cognitive training (Simon et al, 2016).

Self-reported questionnaires are influenced by judgement, expectancy, mood and the cognitive ability to estimate change.
Virtual reality (VR) to reflect real-life cognition

A technology creating a **phenomenal intangible experience** that reproduces real world/physical reality

More accessible, easier to use and to develop
Can be used to design a diversity of multisensorial environments and scenarios

- Reproduces the complexity characterizing everyday life with excellent visual quality.
- Tested in safe environment and conditions.
- Provides objective measurement.
- Can be validated and normed.

Real and virtual appartement

Set of validation studies in older adults

- Appropriate construct (e.g.: sensitive to age)
- Ecological validity
- High sense of presence and motivation
- Few cybersickness symptoms
The loci study: Train and measure transfer with virtual reality
Transfer to a virtual car ride attention (but no transfer on self-reported questionnaire)

**VARIABLE PRIORITY TRAINING**
Vary attentional priority between two concurrent tasks

![Graphs showing dual-task cost for VARIABLE and REPEATED training conditions]
Conclusion

- Cognitive training has a **beneficial** effect on the cognition of persons with MCI and the effect appears **durable** for at least a few months (ACTIVE: 10 year durability in healthy older adults; Rebock et al, 2014)

- Persons with MCI **report using strategies in real life** but demonstrating **transfer** remains challenging, an issue that might be addressed with the help of new technologies.

- Clinicians **should advise** their patients about the **potential** of cognitive training and offer information as to how to access these programs in their community.
Conclusion

Recommendation 1: Communicating with the Public

When communicating with the public about what is currently known, the National Institutes of Health, the Centers for Disease Control and Prevention, and other interested organizations should make clear that positive effects of the following classes of interventions are supported by encouraging although inconclusive evidence:

- **cognitive training**—a broad set of interventions, such as those aimed at enhancing reasoning, memory, and speed of processing—to delay or slow age-related cognitive decline
- **blood pressure management for people with hypertension** to prevent, delay, or slow clinical Alzheimer’s-type dementia
- **increased physical activity** to delay or slow age-related cognitive decline

Other issues

What is the active ingredient, the optimal dose?

Assess the impact on dementia and reserve
  - longer follow-up, large groups, surrogate biomarkers, neuroimaging

Combined approaches are increasingly used
  - Brain stimulation (Benjamin Hampstead), physical activity, nutrition, community-based approach

One size fit all? Probably not. We need to know the responders and measure the effect in less well represented groups (but:
  - less education, various SES and cultural background but...
Cognitive interventions to improve memory in healthy older adults: the use of Canadian (MEMO) and Brazilian (Stimullus) approaches

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Thank you for your attention and take care of your brain health

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